Menlo Park Notebook #6 [N-78-12-04.1]

This notebook covers the period December 1878-January 1879. Most of the entries are by Francis Upton. There are also entries by Edison, Charles Batchelor, and John Kruesi. All of the material relates to experiments on electric lighting. There are many calculations by Upton about generators and system costs, including comparisons to gas lighting costs; drawings and tests of lamps; notes on silicon and graphite; and notes and drawings of generators. The book contains 284 numbered pages.

Blank pages not filmed: 214-249, 254-257, 266-273, 280, 283.

Missing page numbers: 275-278, 281-282.

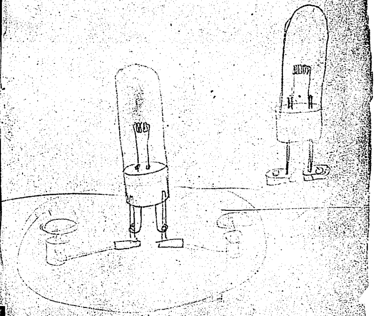
No 6

[illegible] B[illegible] N.Y.C.

May 1, 189.

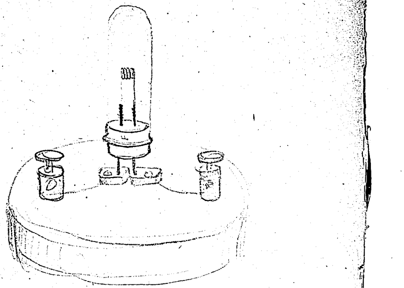
Electric Light Dec 4 17 1878

J Kruesi



Electric Light Dec 10 1878

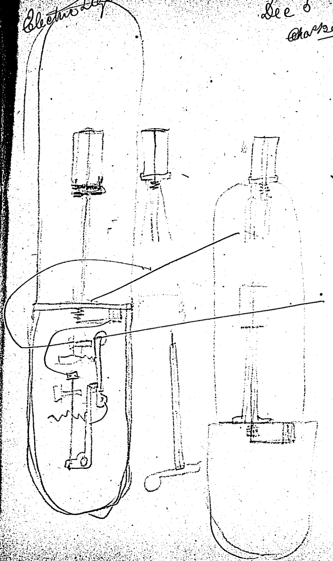
J Kruesi



Electric Light

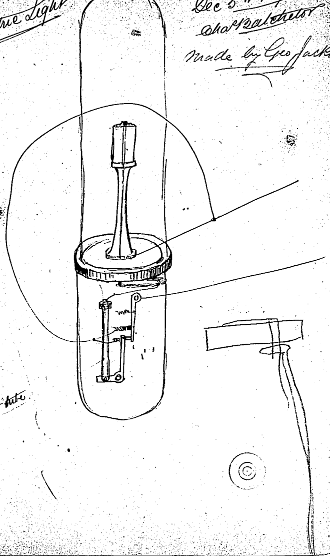
Dec 5th 1878

Chas Batchelor



Electric Light

Dec 5th 1878
Chas Batchelor
made by Geo Jackson



10

$1 = \mathcal{E}\,\frac{1}{1}$ -

$R = \frac{12}{3}$

Heat = C^{42}

$C = 1$

$R = 1$

Heat = 1.

$C = 2$

$R = 1$

Heat = 4

11

$$C = \frac{\mathcal{E}}{R}$$

Heat = $C^2 R$

---

1 HP. $\mathcal{E} = 1$

$R = 1$

$C = \frac{1}{1} = 1$

Heat or work = 1

~~2 HP~~ $\mathcal{E} = 2$

$R = 1$

$C = \frac{2}{1} = 2$

~~Heat or work~~

or H. P = $2^2 \times 1 = 4$

Wallace
100 revolutions

R = 10 Ohms Outside
r = 10 inside

1 Horse power to rotate machine independent of the current

2 Horse power in

Electro motive force = 1

Outside work 6 lamps

Double the speed
H.P. No Lamps?

2~~4~~ inches Batch
19 inches Edison
$7\frac{1}{4}$ 22 " Mark

---

1 H.P. for Elec

$\neq C = \frac{20}{10+10} = \cancel{0}\ \frac{1}{2}\ \cancel{6}$

2 H.P in all Work = ~~1~~
~~½ Work per H.P.~~

---

2 H.P. for Friction
4 Hp for Elec

---

6 H.P. $\frac{2}{3}$ work per HP

6 Hp Work 4

$\frac{2}{3}$ $\frac{4}{3}$ $1\frac{1}{3}$

4 Hp for friction
16 Hp " Elec
20 Hp in all

$\frac{16}{20}$ $\frac{4}{5}$ work for H.p.

No 1^{100} HP Work = $\frac{1}{2}$
$2^{200 \text{ revolutions}}$ " " = $\frac{2}{3}$
$3^{400 \text{ revolutions}}$ " " = $\frac{4}{5}$
$4^{800 \text{ revolutions}}$ " " = $\frac{8}{9}$

8 Hp
64
72

$\frac{64}{72}$ $\frac{8}{9}$

$\frac{3}{2}$

1000 revolutions
Friction 1 H.P.
Elec 1 H.P.

External R = 10
Internal r = 10

1 lamp outside for two Horse Power
10 inches with one unit of work on the ten inches.

$$C = \frac{20}{10+10} = 1$$

~~Heat~~ = C^2R = 10
Heat = C^2R = 20

2000 revolutions
Friction 2 H.P.
Elec ~~4 H.P.~~ ?

External 30
Internal 10

$$C = \frac{40}{30+10} = \frac{40}{40} = 1$$

Heat = C^2R = 30

~~3 lamps for 5 H.P.~~

No. 1. $\frac{1}{2}$ lamp for 1 H
$\frac{3}{5}$ lamps " " "

14

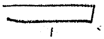
4 000 Revolutions

4 HP. for ~~[illegible]~~

T

HP. for Elec.

10 inside



Exit
Right
5-0
~~[illegible]~~
150

Inc
Left
5-0
~~[illegible]~~
5-0

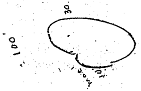
1/2

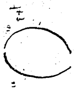
1
3

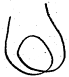
2
4

2

100


30
100
100
10

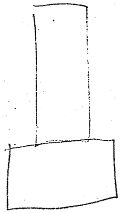




1000 revolutions

2 Horse power put on a Gramme machine will give 1000 revolution the total resistance being 20 Ohms, 10 in & 10 out.

If the Horse Power is doubled i.e. - 4. H. P and the total resistance is doubled i.e. 30 out 10 in = 40, the speed of the machine will increase to 3.000 revolutions and doubles



a Gramme machine
Gives 85° in work

the work will be ob-
tained,

2 H.P.

Perfect Gramme

1 H.P 1000

10 inside 20=E
10 outside

C = 1 Total Work = 20
Useful " = 10
Useless " = 10

1 HP 2000
5 inside H
15 outside

18. Total = 20.
~~15~~ Useful = 15
Useless = 5.

4000 revs

2 1/2 inside

17 1/2

17!

20 total
17 1/2 useful
2 1/2 useless

1 1/4 8000

x

x

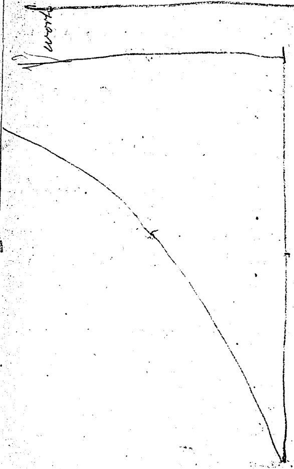
3/4 16000

3/8 32000

Perfect Gramme

If the speed is doubled the electromotive force is doubled. If the internal resistance is halfed the E-F is halfed, at the same time [illegible] ~~and~~ external increased half; Total the same, If both at same time Elec-Force remains constant

Gramme 85 % Elec
15 % Friction



50 % friction
50 % Electricity   Gramme

1 H.P. Friction   1000 revs = 2 H.P
1 H.P Electricity

10 out = R   C = 1
10 in = r

Work = 20 units
useful = 10   5 useful
useless = 10   per H.P.

15 out   2000 revolu.
5 in

~~2~~ H. P friction
1 H. P Elec = 3 H. P

Work 20
useful 15   5 useful
useless 15   per H. P.

72 Friction
28 Current = Wallace

1. H.P Current
3 H.P Friction

1000. revs

10 in
10 out

20 work
10 useful
10 useless

Useful [illegible] $2\frac{1}{2}$ hrs. H.P

2000. revolutions

5 in
15 out

20 work
15 useful
5 useless

---

6 Hp Friction
$\underline{1 \text{ H.P.}}$
7

$\frac{15}{7} = 2\frac{1}{7}$

[illegible] [illegible] for Gramme

45 Friction
55 Current

$\frac{1}{4}$ Current
$\frac{3}{4}$ Friction $= 1$ HP

$1\frac{1}{x}$

---

4 HP

2 30 Siemens   15 Frictions
85 Current

[illegible]   [illegible] $\frac{3}{13}$ H.P. Friction
1 H.P. Current

~~[illegible]~~ revol
10 in
10 out

work 20
useful 10
useless 10

$\frac{10}{1\frac{3}{13}}$ 8.1 Useful per H.P

~~Exp revolution~~
5 in
15 out

$\frac{6}{13}$ Friction   20 Work
1 Current   15 useful
5 useless

$1\frac{6}{13}$ Total H.P

10.2 Useful

31

~~2~~ $\frac{3}{13}$ 13) 3.0 (.23
26
40
39

1.92

1.23) 10.00 (8.1
984
160   1.92) 17.5

1.46) 15.0 (10.2
146
400

4X
$2\frac{1}{2}$ 2.5
$17\frac{1}{2}$ 17.5

4000 revolutions

$\frac{12}{13}$ Friction $17\frac{1}{2}$ useful
1 Current $2\frac{1}{2}$ useless

$1\frac{12}{13}$

$\frac{1}{2}$ Friction = 1

$\frac{1}{2}$ Current

4 ounce

1 Friction 4

2 Current 3

4 do

3 Work 4

$\frac{1}{2}$ Work 1

$\frac{1}{2}$

$\frac{3}{4}$

2 cars

½ H.P. friction

½ H.P. Current

---

4 cars

1 H.P. friction

2 H.P. Curr

3

13)100 (.8

April 1

④ Friction 1 H.P. $\frac{20}{10}$

Current 1 H.P.

---

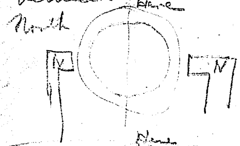
⑤ H.P. 6 H.P.

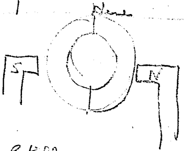
Friction 2 H.P. $\frac{8.0}{.6}$

4 H. P

4 times Current 13.

Rotating effect more
ring soft as magnetism
as when still when
between the two poles as





Still none
Rotating same
Perhaps the covering of brass
carried the currents around the
Not so the same with out a helix.

Wallace

3 Hp Friction 20
4/5 1 Hp Current
4

6 HP
4/10
8
80

8. 14 Hp 3.5) 6000 (1200
3300
[illegible]

Siemens

Hp. 8) 14000 (1
8000
6000

Hp. 2) 1200
600

1750

600
1200
1750

Electro Magnet

Wire 0,0033 Metre
Weight of Cu. 24. Kilo

Coil
Weight of wire wound
14 Kilo

Diameter of wire 0,0026 Metre

Magnet 0.0038 Metres

Weight 14,3 Kilo

Coil Diameter 0.002
Weight 4.25

.02

.09

48

The combustion of a cu-ft of common gas will heat 65 Gallons of H_2O 1°

Haswell.

---

65 Gallons 1 Gal = 8.32 Lbs.

8.32
65
4160
4972
54 .80 lbs
5 cu. ft. a hour for one burner
270 4.00
772 ft. lbs. for 1° Fahr.

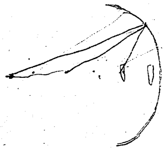
2704
772
5408
18928
18928
2,087,488 ft. lbs.

2.087.488

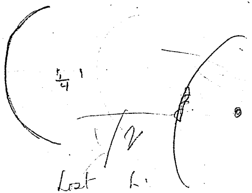
33.000
60

1,980,000) 2,087,488 (1.07
1980000
1.07 04.880

1 Gas burner 5 cu. ft. per hour would drive if all its heat could be used a one horse power engine with a little to spare ✓



Mirror 1 in radius.



Lost L.

96. 4 90.

1/2

adjourned

1/8

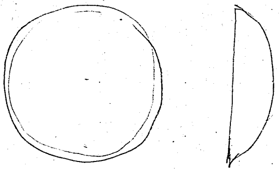
8'

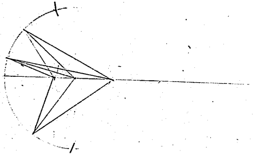
92

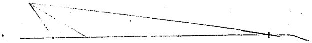
Portland

Portland

Portland







6 ft $8\frac{1}{2}$ in

4 wires No. 36

6 ft $8\frac{1}{2}$

4

---

30 90. 6.66

6.7

$6.7 \overline{)\,90.0}\,(13.$

67

230

211

90

6 [illegible] 2 ff ?

15

Lamp

Gramme machine

1 Ohm ✓

One inch incandescent Pt will give light equal to one gas burner. Therefore to have six lights per horse power, a machine using one horse power must heat a wire of [illegible] with five inches of surface white hot. ✓

Iron wire 0.017 in diam.

7 feet

12
7
84
.053
252
420
4.452

~~.017~~
3.14
.017
2198
314
.05338
7

3.14
.017
2198
314
.05338
84
212
424
4.452

2 candle 10 cells

260 260

26
2
15)52
3

2 candle

Four iron wires .017 in in diametre were heated to a dull red by the Gramme machine, Their resistance was estimated at $\frac{1}{2}$ Ohm and their surface at 15 inches ✓

1000 lbs for 24 hours heating building

~~1200~~

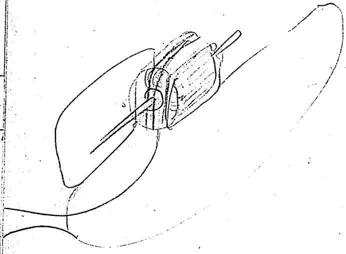
1200 lbs for the engine working 12 hours ~~&~~ giving about 10 horse power

10 lbs per hour

$4.30 for 2200

2200) 4,30.00 (.002 1/5 ct
4400

1/5 ct per lb

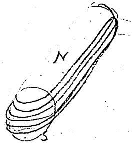


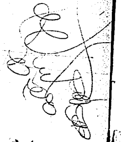
6.5 4

.8

54.0

6.





34
12

108
54

648

.017

3.14
.017

2198
314

.05338
648

4264
2132
3198

34.5384

136.

50

24

99·1 :: 1

4

6/1·100
·183

46+6" of 33 copper wire

46/99·+

2

99 : 1 9.9/46·00/·5

99·1 : 1 :: 46·5 : ·4 7/18

9.9/46·50|·47
39 64
·686|9
693|7

47/16

54

Jan. 13. 1879

Jablochkoff.

2½ h.p. 50.
Carbon 100
150.

Light unopposed 3500 candles
modified 1750 cands;
in - 5 places,

E

15 h.p.
Cost 150, -

Total light. 13.50.

Distribution 90 at 15

15
90
13.50

1350
450
E 1800,
Jabk. 1750.

½ Jablochkoff costs 2½ H.P.
say 25 cts. for power
50 cts " carbon
75 cts.

will pay for 7½ H.P.

7½

Jan. 13 6 lights per horse power
45
2 Glass globes round the Jablochkoff
90 Lamps

15
6
90.

90
15
1350 candles

2½ Jab = 2500

But 1350 candles can be distributed add ⅓ or more 1700

Labor not counted

Jan 13

,24

3.14
.33
2

3.14
.24
1256
628
.6536

16)5.0(31
48
20

3.14
31
314
942
.9734

1.1[illegible]

~~24 inches~~

Gas costs. say 1.00 per 1000 ft.
1 ct per 10 ft

~~1.5 cts per 15 ft or [illegible]~~
.5 ct per 5 ft

H.P. cost $\frac{4}{5}$ ct per hour
say 1 ct per hour

2 lamps per horse power would pay

Jan 16

13 raw 4 each
4
52

when red hot 5 X 4 = 20
ohms in each

$$\frac{20}{13} = 1.54 = \text{Resistance in all}$$

13)20(1.54
13
70
65
50

Belt for two horse power

8)56 Lamps heated
7
8 times as much
for incandescence

3½ per horse power

Jan. 15 1.300 5000 ft

347 mm

Yellow bright

620 mm heated

on ~~Bright~~ Grayness red when 13 mm

given spiral fine a wire wire in multiple arcs

with 9.8

9.8
4.1
98
342
40.18

150)620(4.1
600
200

~~1327~~
~~4.1~~
~~508~~
~~512.01~~

499
4.1
500
2050.0

2050 energy given off on 620 mm wire

~~1050~~

620 mm
4
2480

.004
3.14
.004
.01246

248
.0124
992
496
248
.30752

Yellow

150) 380 (2.5
200
80

11.
2.5
55
22
27.0

White

150) 220 (1.46
150
700
600
~~1000~~
900

18.5
1.46

Duncan

150) 193 (1.2
150
430
300
130

1.2

1720
1.2
3440
1720
2064.0

Melts 17.2 mm

6.39
1.2
1278
639
7.668

Cold

639
41
639
2529
25.930

Platina Experiments.

Piece wire - pt. 440 mm long - wire flattened into a ribbon - weight after cleaning by momentary incandescence, 0.3430, grammes. We now place it on Gramme machine for 3 hours —

Jan 30 1879

Silicium or Silicon =

Watts p.267 Vol V

Obtained in free state by action of reducing agents on the chloride ~~and~~ or fluoride and assumes the 'amorphous' 'graphitoidal' or crystalline state according to the mode of separation.

Amorphous Si is brown powder, non conducting fuses at melting point of steel in an non oxidising atmosphere,

Graphitoidal;—

May be heated to whiteness in O. without undergoing any alteration in weight. I wonder whether this is a conductor.

Made by fusing 1 pt Aluminium 5 pts glass free from lead 10 pts powd. Cryolite together, treat the mass with HCl, then with Hydrofluoric Acid

Graphite Silicium   Try this

Fuse in Hessian crucible

5 parts Soluble glass (Potassium Silicate)
10 parts Cryolite (Sodium + Al fluoride)
1 part Aluminium

Treat the button with HCl. Si remains in shape of scaly crystals, like graphite. It is infusible   Fowne 210

.0143 To be multiplied by the square root of the numerals

.000162 To be multiplied by the numerals.

.001208 To be multiplied by the square of the numerals

Divide the last product by four. (4)

4) 125
31 $\frac{1}{4}$

(2)

.0143
1.41
0143
0572
0143
.020163

.000162
2
.000324

~~.0125~~
~~4~~
.0500

4) .0500
.0125

~~.001208~~
~~4~~
~~.004832~~

~~4) .004832~~
~~.001208~~

(3)

.0143
1.73
0429
1001
0143
.024739.

.000162
3
.000486

~~1.001208~~
9
.010872

~~4) .010872~~
~~.002718~~

.0125
9
4) .1125
.002814 $\frac{1}{4}$

(4)

.0143
2
.0286

.000162
4
.000648

.0125
16
0750
0125
.02000

~~.001208~~
~~16~~
~~007248~~
~~001208~~
~~0.019328~~

4|.02000
.00500

~~4)0.019332~~
~~0.004833~~

* * *

(5)

.0143
223
0429
0286
0286
.031889

.000162
5
.000810

.0125
25
.0625
0250
0,3125

~~.001208~~
~~25~~
~~006040~~
~~002416~~
~~0.030200~~

~~4)0.030200~~
~~0.007550~~

4)0.3125
0.0781$\frac{1}{4}$

(6)

.0143
2.44
0572
0572
0286
.034892

.000162
6
.000972

.0125
36
.0750
0375
0.4500

4)0.4500
0.1125

* * *

(7)

.0143
2.64
0572
0858
0286
.037752

.000162
7
.001134

.0125
49
.1125
0500
0.6125

4)0.6125
0.1531$\frac{1}{4}$

(8)

.0143
2.82

0286
01144
0286

.040326

.000162
8

.001296

.0125
64

.0500
0750

0.8000

4) 0.8000

0.2000

(9)

.0143
3

.0429

.000162
9

.001458

.0125
81

0125
1000

1.01125

4) 1.0125

0.2531$\frac{1}{4}$

(10)

.0143
3.16

0858
0143
0429

.045188

.000162
10

0.001620

.0125
100

01.2500

4/1.2500

0.3125

(11)

.0143
3.31

0143
0429
0429

047333

.000162
11

000162
000162

0.001782

.0125
121

0125
0250
0125

1.5125

4) 1.5125

0.3781$\frac{1}{4}$

(12)

.0143
3.46
0858
0572
0429
.049478

.000162
12
000324
000162
0.001944

.0125
144
0500
0500
0125
01.8000

4)0.18000
0.04500

(13)

.0143
3.60
085830
0429
.051480

.000162
13
000486
000162
0.002106

.0125
169
1125
750
125
2.1125

4)2.1125
0.5281$\frac{1}{4}$

(14)

.0143
3.74
0572
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.0572

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(58)

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(66)

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ok

4 59.51 3.677698
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(70)

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(74)

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(78)

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(82)

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$\bar{1}.150540$

1571 1.986772

$\bar{2}.197072$

$\bar{2}.196287$

3.973544

4|1176 2.070444

29.40 2.070454

---

(98)

.1421 0.995613

$\bar{1}.153213$

$\bar{1}.152767$

.0158 1.991226

$\bar{2}.201526$

$\bar{2}.200741$

3.982452

4|1200 2.079352

304 2.079362

(99)

.1428 0.997817

$\bar{1}.155417$

$\bar{1}.154971$

.01603 1.995635

$\bar{2}.205935$

$\bar{2}.205150$

3.991270

2.088170

4|122.5 2.088180

30.62

(100)

.1436 1.000000

-1.157600

-1.157154

.01620 2.000000

-2.210300

-2.209515

4/1250 4.000000

3125 2.096900

100 2.096910

2.004321

(102)

2.008600

(103)

2.012837

2.017033

2.021189

2.025306

2.029384

(108)

2.033424

109

2.037426

(110)

2.041393

(111)

2.045323

(112)

2.049218

(113)

2.053078

(114)

2.056905

115

2.060698

(116)

2.064458

117

2.068186

118

2.071882

119

2.075547

(120)

2.079181

121 ~

2.082785

(122)

2.086360

123 ~

2.089905

124

2.093422

125

2.096910

126

2.100371

127

2.103804

128

2.107210

129

2.110590

130

2.113943

131

2.117271

132

2.120574

133

2.123852

134

2.127105

135

2.130334

136

2.133539

137

2.136721

(138)

2.139879

139

2.143015

140

2.146128

141

2.149219

142

2,152288

143

2.155336

144

2.158362

145

2.161968

146

2.164353

147

2.167317

148

2.170262

149

2.173186

150

2.176091

151

2.178977

152

2.181844

153

2.184691

154

2.187521

155

2.190332

156

2.193125

157

2.195900

158

2.198657

159

2.201397

160

2.204120

161

2.206826

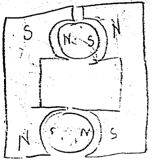
162

2.209515

163

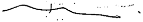
2.212188

164



2.214844

165

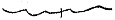


2.217484

166

2.220108

167



2.222716

168

2.225309

169

2.227887

170

2.230449

171

2.232996

172

2.235528

173

2.238046

174

2.240549

175

2.243038

176

2.245513

177

2.247973

178

2.250420

179

2.252853

180

2.255273

✓

181

2.257679

182 1.079 1.125

$\bar{0}.0330$
0.0511
$\bar{1}.9819$
2
$\bar{1}.9638$

92
9
838

2.260071

✓

183

2.262451

184

2.264818

185

2.267172

186

2.269513

187

2.271842

188

2.274158

189

2.276462

190

2.278754

191

2.281033

170

192

2.283301

193

2.285557

171

194

2.287802

195

2.290035

196

2.292256

197

2.294466

198

2.296665

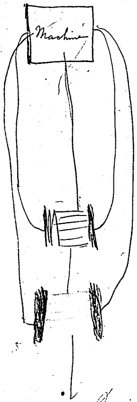
199

2.298853

200

2. 301030

L



4 to one

4 to one

4 to one

20 per cent

20 2 2

2

20 20

20 20

20 2

20 20

20 20

20 20 20 20 20 20

20 20

10% 10%

10% 10% 10%

10% 10%

10% 10%

3 hours.

Central Station

100 for a machine for 25 lights

$ 6.

Conductor outside Esti 2.

Lamp 3.

1 Lamp capital $11

---

300 hours a year

~~300) 11.00 (~~

~~3.66~~ cent

$ 1.10 interest

300) 1.10

.00366

3.66 mills per hour

100 machine 20 lights

$ 25 a H.P.

45

5

8

Boiler

Engine $25 a H.P.

10

87

$25

87

$ 2

5

$19.

40

10

397

$18 a lamp

$18.00

300)1.80

.006 mills per hour

$19

)1.90

1.90 0.

365 2.

$ 10000,000

500,000.~~000~~ 1000 feet

100,000,000 burners an hour

~~10,000,000~~

1 ~~00,000,000~~

$\frac{1}{10}$

1.~~000.000~~

5 ~~00,000,000~~

$ 10,~~000,000~~

5 ~~00,000~~

1~~000,000~~

5~~00,000~~

$2

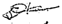
$\frac{\$10}{5}$. $2 a year interest

500,000

1,000,000

500,000

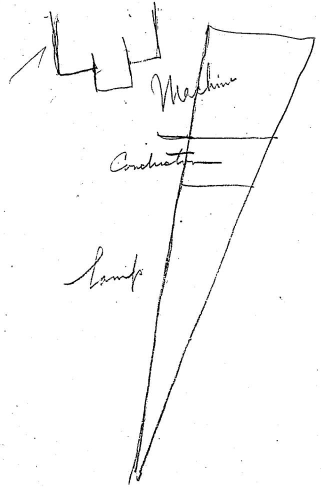
~~15~~ 100.000.000.

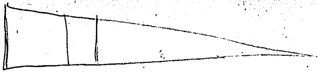


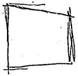
~~10,0~~[illegible]

1[illegible]

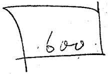
200000

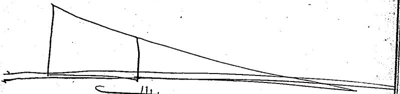

Machine
Conductor
Lamp

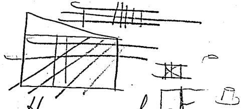




1 House

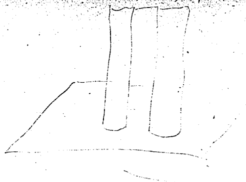


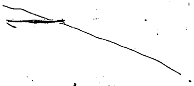




How much

Howmuch will the E.M.F
drop when one lamp is
or many?





1 in 10

1 ohm machine
100 ohm lamp
1 ohm in conductor for
10 lamps

In lamps 5 units
In mach 1 un
line 1/2 unit

---

5 .10
1 2
1
100
13.

13)100 (78
91
90
78
156
7.8
4

10   5
2   ~~1~~
1   1
13   2

No. 1

Lamps	10
conductors	1
machine	1
	12 units

12)100(8.3
96
40

83

12 units of

12)100(8.3

83
8.3
8.3

~~18~~
5 10 lamp
-1 2 Machine
1/2 1 Conductor

13

13) 100 (7.7
91
90

7.7

7.7 lamp
15.4 machine
7.7 Conductor

1/2 Ohm Conductor
1 Ohm machine
100 Ohm lamp

77

77
15
7.7

23

1 lamps 100 50

1/2
1

100 = diff 9

50
1
2

103) 1000 (.0097
927
730

2 lamps 97

53)100 (1,88
53
470
424
46

= 0

50 150
1 2
1/2 1

25
1
1/2

50
2
1

1,88
50
9400

103)100,0 (97
927
730

53

53)100.0 (0.188
53
470
428
420

1,88
50
9400

25
1.
2

3 lamps 94

94

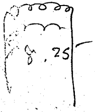
---

8 lamps

12.5 lamps
1/2 conductor
1 mach

25
~~2~~
2
28)100 (356
84
160
140
200
168
32

357
25
1785
714
8825



197

16 lamps

100

12.5

25 6.25 lamps

2 1/2 conductor

4 1 machine

.31) 100 (322

93

70

62

80

32~~2~~

25

1610

644

80.50

198

1 lamp

100ω 99

1 Ohm machine & conductor

---

2 lamps

50

1

51

51) 100 (196

51

490

459

310

306

40

196

50

9800

4

25

1

26) 100 (384

78

220

208

120

100

384

9616

~~384~~

8

12,5

1

27) 100 (37

81

190

187

37

25

180

72

900

16)

6,25

1.

7,25

25

4

29) 100 (344

87

130

116

140

31

25

155

62

775

31

(34400

86

4 (37

9,22

20 lamps

5
1
6)100(1
166

1.66 ~~6~~
5 ~~9.9~~
833

83 lamps
8.5 conductor
8.5 machine

1/2 1/2

~~99.3~~ 2

~~100 0.1 9900~~

50
1
51

51)100(196
51
490
459
310

100
196
98.04

4

25
1
26)100(346
88
120
104
160

100
346
9654

218

8 No 13
$\frac{13}{8}$

1250 1.3

or II

8 in series 1 Ohm each

E = ~~64~~ 1.

C = [illegible] $\frac{1}{8}$

Magnet strength

$= \frac{1}{8}$

Each magnet Cost $= \frac{1}{64}$.

8 magnets 64 ohms in multiple arc

in each

$\frac{1}{64}$ = current

$\frac{1}{64} \times 64 = 1$ strength

Cost $\frac{1}{64}$ the same as before while strength of magnet 8 times greater

$\frac{20}{7000}$

700) 2 (

$\frac{1}{350}$ Weber

$\frac{1}{350} \times \frac{1}{350} \times \frac{20}{\cancel{7000}}$

$\frac{2}{35}$ $\frac{1}{17}$ Erg

1 Ohm 1 cell

2 Ohm

$\frac{1}{4}$ Weber.

$\frac{1}{16} \times 4 = \frac{1}{4}$ [illegible]

$\frac{1}{2}$ ~~10~~ Strength

$\frac{1}{\cancel{350}} \times \cancel{7000}$

20 = Strength of magnet

40 times as strong

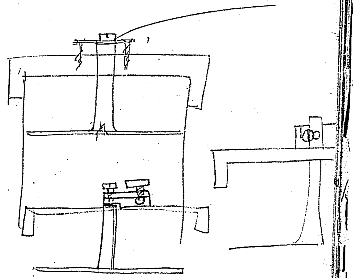
160 times better

2888
2780
2

.4606
.4440
.0166

Make 3 buttons the old way –

Sat. Sol. Caustic Soda



8
8
1648
44.3
64
1772
2658
28)2835.2(10100 ft lbs
28
35
28
72

168)1650(8
1344
306

168)1650(.98.2
1592
1580
1344
360

9100

10000
8250
18250

16.5)1.000(

33000
5
165000
1825
47500

165000
18250
183250

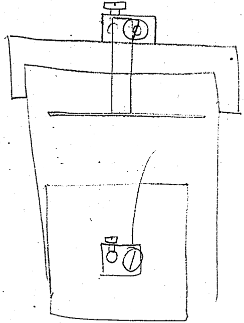
183.25)18.25

165000
8250
173250

173)1000(5.2
965
350

10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10

11



1.019 Ohm

1.019 Ohms.

Ohm 1.0196 Absolute
Kohlrausch

9/ E.M.F measured on Ohm

1,02

$\frac{11.24}{1.02}$

$$\begin{array}{r} 1.0504 \\ .0086 \\ \hline 1.0418 \end{array}$$

11.24 Absolute

1.101

1.125

$8/9 \overline{)1.125}$

Armature

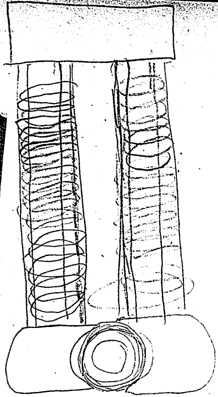
$$1 + \frac{a^2+b^2-c^2}{2ab}$$

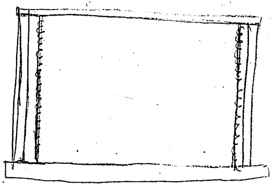
$$\frac{2ab + a^2+b^2-c^2}{2ab}$$

$$a^2+2ab+b^2 = (a+b)^2$$

$$(a+b)^2$$

$$a^2+b^2+2ab$$

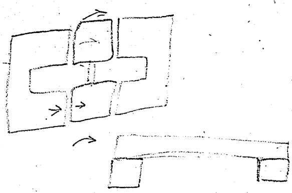


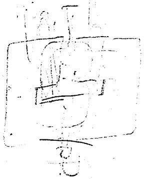


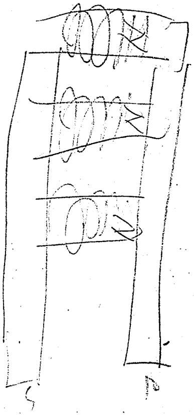
30 : 55

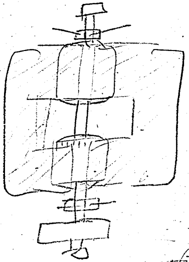
55 : 30 :: 25 :

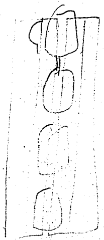
```
       30
55) 7 5 0  ( 13.6
    5 5
   -----
    2 0 0
    1 6 5
    -----
      3 5 0
```

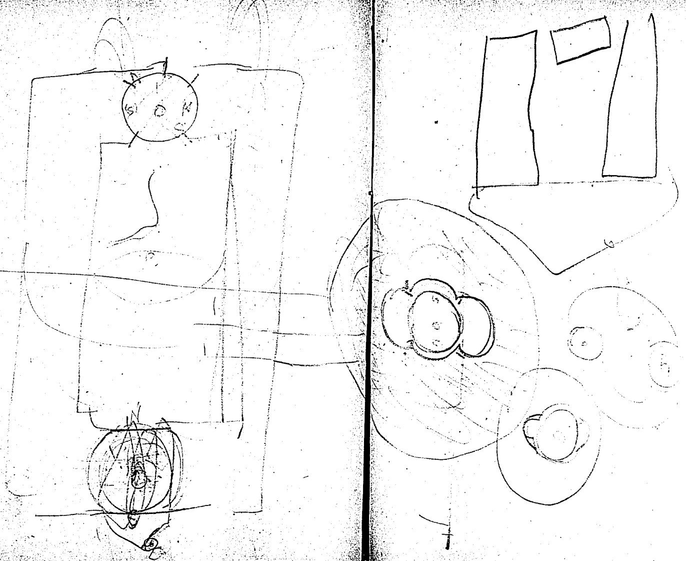




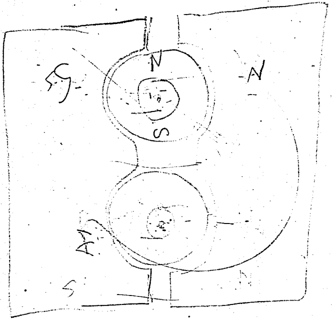

S
P

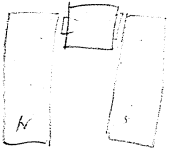


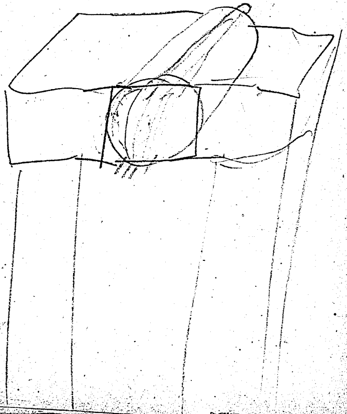


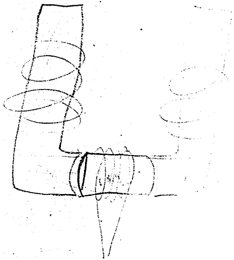


[illegible]


S
N
N
S
N
S
N


N
S

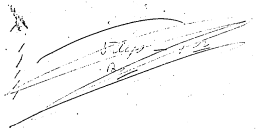




Pages torn out by
(one batch
no experiment on)

Multiply each numeral by 20 that is 1. 2. 3 4, 5, 6 1/5 [illegible]

	feet	$\sqrt{\ }$	( ) Number multiply by the 1:2	$(\ )^2$ 7	~~$(\ )^2\times 4$~~ $(\ )^2 \div 4$
1	20				
2	40				
3	60				
4	80				
5	100				
6	120				



D.	cross section	[illegible]
.01426	.000182	[illegible]
$\bar{2}.157400$	$\bar{4}.210200$	[illegible]